

Original Article

Comparison of Sagittal Condylar Guidance Determined by Panoramic Radiographs to the One Determined by Conventional Methods Using Lateral Interocclusal Records in the Saudi Arabian Population

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Received : 12-01-19.
Accepted : 15-02-19.
Published : 04-11-19.

INTRODUCTION

The most important consideration in the oral rehabilitation of a patient is the condylar path inclination. Condylar path is defined as the path traversed by condyle in relation to the articular eminence when the patient's mandible is moved either in protrusive or in the lateral direction from centric relation. Condylar guidance is the mechanical form located in the upper posterior region of an articulator controlling the movement of its mobile member.^[1] The purpose of taking interocclusal records is to set the condylar elements of the articulator so that they

ABSTRACT **Objectives:** The objectives of this study were to determine the condylar guidance by the conventional method using interocclusal records and by panoramic radiographs in healthy dentate patients and to compare the values obtained from panoramic radiographs with the values obtained by a conventional method. **Materials and Methods:** Thirty healthy dentulous subjects of either sex with an age range of 20–40 years visiting Jazan University, College of Dentistry, Dental Clinics for replacement of missing teeth or crowns, were selected according to the inclusion criteria. Maxillary and mandibular casts were obtained and mounted on Whipmix 2240 articulator. Right and left lateral interocclusal records were then made in patients by base plate wax (Dentsply truwx baseplate). This record was transferred to articulator, and condylar values were determined. In all the cases, articulator was programmed. Left and right condylar values were also measured on digital radiographs and readings were recorded. Condylar guidance readings obtained from interocclusal records and those obtained from panoramic radiographic images were compared and analyzed statistically using the *t*-test. **Results:** The condylar guidance values obtained from the interocclusal record method for both left and right sides were less when compared to the values obtained from tracing the panoramic radiographs (radiographic method). The difference in values of both the methods was highly significant. **Conclusion:** Although a significant amount of correlation was found between the two methods, better radiographic techniques should be further investigated.

KEYWORDS: Condylar guidance, interocclusal records, panoramic radiograph

will reproduce inclinations, comparable to that of the patient's temporomandibular articulation.

Programming of the semi-adjustable articulator is an additional step that is deemed mandatory for the fabrication of good removable or fixed prosthesis. Programming of the semi-adjustable articulator refers to adjusting the horizontal condylar guidance

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How to cite this article: Dewan H, Akkam TI, Chohan H, Sherwani A, Masha F, Dhae M. Comparison of sagittal condylar guidance determined by panoramic radiographs to the one determined by conventional methods using lateral interocclusal records in the Saudi Arabian population. J Int Soc Prevent Communit Dent 2019;9:597-604.

Access this article online

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DOI: 10.4103/jispcd.JISPCD_11_19

and lateral condylar guidance and incisal guidance. This angle varies from person to person and from one side to the other. The goal of registering this condylar guidance is to program the articulator for simulating the patient's condylar movements as accurately as possible to save chairside time involved in adjusting the occlusal interferences at the time of delivery.^[2]

Various methods (intra- and extraoral) have been used to register the path of the condyle and adjust the articulator accordingly. Centric and eccentric relations can be recorded through the positional wax method, functional recordings, graphic recordings, and cephalometrics. Instability of materials and changes during their setting are sources of error that arise in laboratory procedures despite accurate registration methods.^[3] The reliability of wax records for interocclusal records has been questioned as three separate records will yield three different values for condylar guidance.^[4]

Literature indicates the use of lateral cephalogram, tomography, and pantomographs for recording condylar guidance. Studies have shown that radiographic methods (RMs) can record condylar guidance much more accurately.^[5-7]

The articular eminence's outline and the glenoid fossa have been evaluated on panoramic radiographs and have been suggested to be an important aid in setting the condylar guidance in semi-adjustable articulators.^[5] There are no studies in the dental literature for the Saudi Arabian population, comparing condylar guidance obtained with interocclusal records and panoramic radiographic images. This study sought to evaluate the two techniques, for recording and for determining the condylar guidance.

MATERIALS AND METHODS

This study was prospective and took around eight months for completion. Two visits from patients were required, first for panoramic X-ray and alginate impressions and second for the interocclusal record. Thirty healthy dentulous subjects of either sex with an age range of 20–40 years visiting Jazan University, College of Dentistry, Dental Clinics, were selected after obtaining ethical clearance from the institutional ethics committee and after obtaining patient consent in a written form (consent form enclosed). The sample size was selected taking into consideration other relevant studies. Patients free of Temporomandibular joint (TMJ) disorders, with good neuromuscular control, and dentulous subjects with three teeth in each of the posterior quadrants were chosen. The exclusion criteria included patients with a history of orthodontic treatment; patients with deep bite and anterior malocclusion, progressive periodontal disease, major restorations, and gross attritions; patients with less than three teeth in each of the posterior quadrant and lack of adequate neuromuscular control of jaw movements; and patients with gross facial or skeletal malformations.

INTEROCCLUSAL RECORD METHOD

Maxillary and mandibular impressions were made using Zhermack tropicalgin alginate (Bovazecchino, Italy) which is an irreversible hydrocolloid impression material and casts were poured immediately in dental stone. Using face bow transfer [Figure 1], the maxillary casts were mounted on Whipmix 2240 series (Louisville, USA) semi-adjustable articulator, and mandibular casts were mounted using the patient's maximum intercuspation record [Figure 2]. After mounting maxillary and mandibular casts on the articulator,

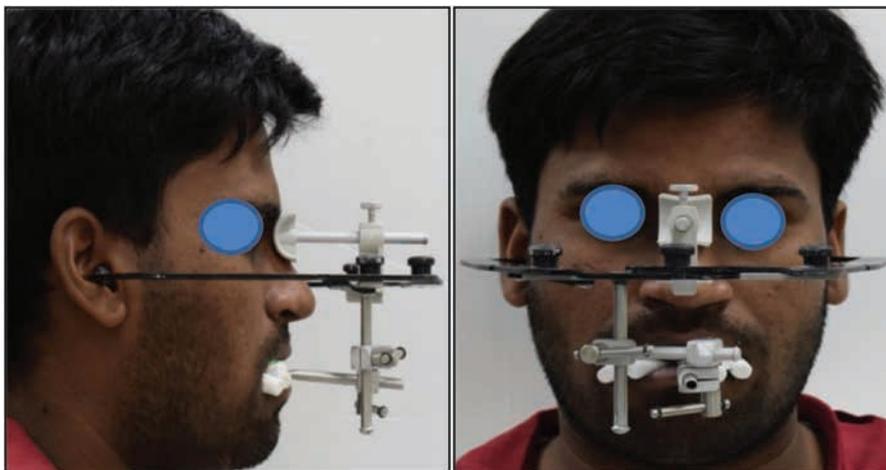


Figure 1: Facebow registration

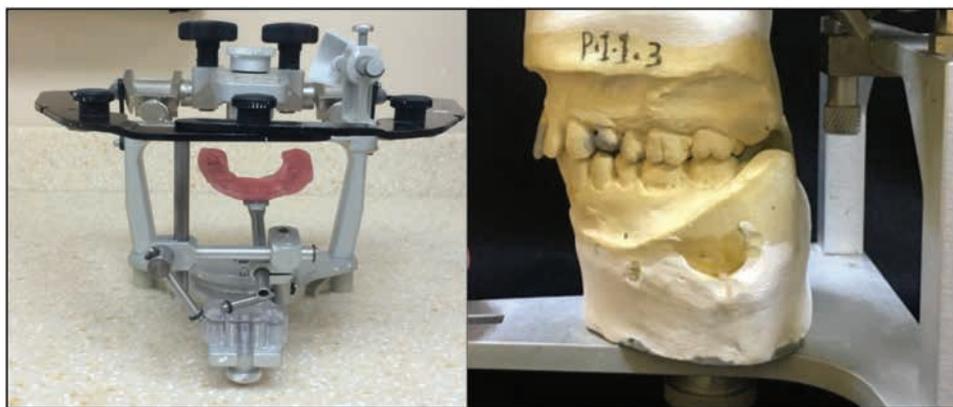


Figure 2: Facebow and mounting of maxillary and mandibular cast



Figure 3: Interoclusal records

right and left lateral interocclusal records were made in the patient using modeling wax (Dentsply truwax baseplate) as the bite registration material [Figure 3]. These records were then transferred to the articulator to set the condylar values. In all the cases, articulators were programmed^[8] by a single operator to determine the condylar values, and the readings were recorded [Figure 4].

RADIOGRAPHIC METHOD

All the Orthopantomogram (OPG) were made in an open mouth position to prevent the superimposition of the image of the condyle over the glenoid fossa in the radiograph. Exposure parameters were set to the standard of 78 kV, 8 mA, and exposure time of 10s on the panoramic machine (MODEL orthorelix DDE; GENDEX, USA). A lead apron was used for the subject during exposure to minimize the stray radiation.

ANALYSIS OF THE OBTAINED RADIOGRAPHS

The Frankfort's plane was used as the reference plane for this study. The following salient points were identified and digitally traced on the OPG. Frankfort's plane (yellow line in Figure 5) was drawn from the porion (plotted to coincide with the superior border of

the radiolucent image of the external auditory meatus) to orbitale (the lowermost point on the lower orbital rim). The outline of the glenoid fossa and articular eminence was marked (red). Point A depicting the deepest point in the glenoid fossa and point B depicting the highest point on the articular eminence were marked. A line was drawn joining the points A and B (blue line in Figure 5). The angle formed by the line joining the points A and B to the line representing the Frankfort horizontal plane was measured and read as the horizontal condylar guidance angle value obtained by panoramic radiographs. This procedure was carried out in all the subjects. The readings were tabulated and subjected to a *t*-test for statistical analysis.

DISCUSSION

Statistical analysis showed a significant difference between the values obtained by the interocclusal record method (IRM) and RM on the right and the left side ($P < 0.005$).

The values for condylar guidance on the right and left side obtained from IRM and RM are shown in Table 1.

Table 2 shows the summary of the values for the IRM and the RM for the right and left condylar guidance of the subjects.

Table 3 and Graph 1 show that there was a significant difference in the IRM and RM on both right and left sides. The RM (in degree) had a significantly higher value than IRM on right and left sides.

Table 4 and Graphs 2–5 show that there was a significantly positive correlation of IRM on the left and right side ($r = 0.614$); there was a significantly positive correlation of RM on the left and right side ($r = 0.697$); there was a significantly positive correlation of IRM with RM on the right side ($r = 0.658$); and there was a

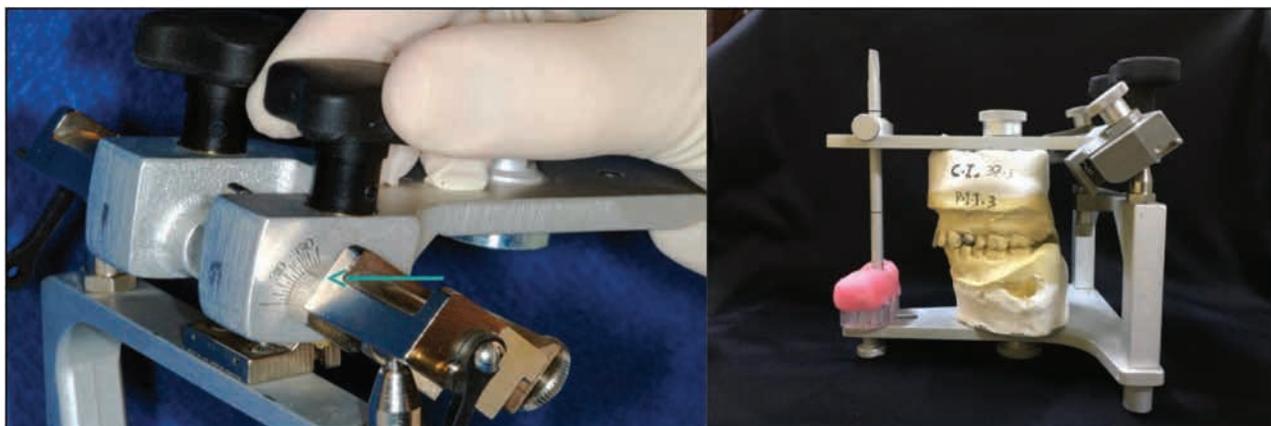


Figure 4: Programming of the articulator

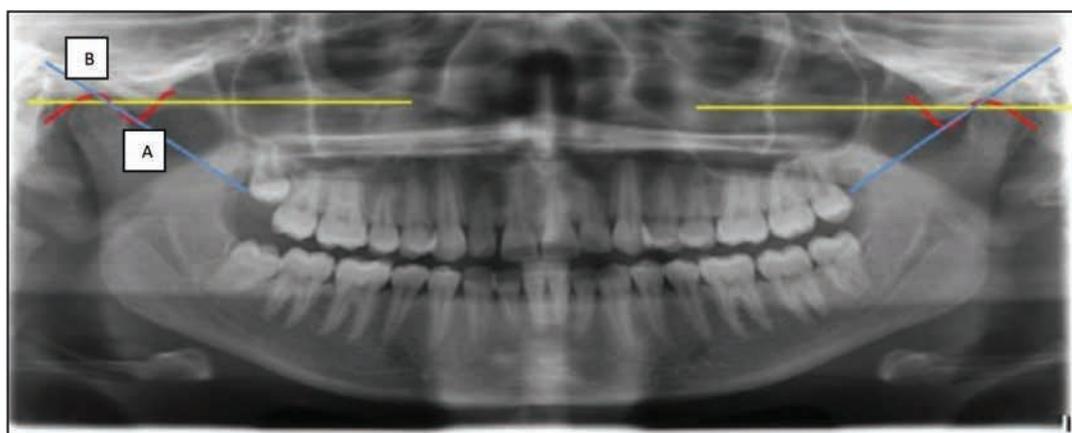


Figure 5: Condylar guidance measured from the OPG (Red line - Outline of the glenoid fossa and articular eminence; Yellow line - Frankfort's plane; Blue line - joins deepest point on the glenoid fossa (Point A) and highest point on the articular eminence (Point B))

significantly positive correlation of IRM with RM on the left side ($r = 0.658$), respectively.

The two controlling factors that determine the mandibular movements are the condylar path in the TMJ as the posterior controlling factors and the anterior teeth as the anterior controlling factors. The condylar path is peculiar to each patient. The condylar settings should be adjusted using protrusive and lateral interocclusal records. The practical consequences of setting the articulator's condylar guidance higher than the subject's relative angle could result in prosthesis with protrusive and lateral interferences. Hence, it is very important to set the condylar guidance angle close to what actually is present, to avoid the resultant interferences.^[9]

Several factors could account for the difference in registered values between the clinical and the radiographic methods, with the latter yielding higher values. The difference could be partly due to errors in the clinical method and radiographic method.^[10]

The results for the condylar angles also vary with the patients' sides.^[11]

The panoramic radiographic image of the sagittal outline of the anatomic landmarks (i.e., articular eminence and glenoid fossae) was identified in most of the subjects. Five subjects could not be considered in the final analysis because of poor radiographic images. The temporal bone on a panoramic radiograph depicts two radiopaque lines; the lighter and superior one is the articular eminence and fossa, and the heavier and inferior one represents the inferior border of the zygomatic arch.

The mean condylar guidance values obtained using the radiographic method was 42.57° on the right side and 42.71° on the left side and those obtained by the interocclusal method was 36.36° on the right side and 35.85° on the left side (Graph 1). Literature suggests that the right and left eminences seldom have the same slants and contours.^[12] Using a gnathograph, the average condyle path angle of the left and right condyle was reported as 35.11° and 36.02° , respectively. In

Table 1: Condylar guidance on the right and left side obtained from interocclusal record method and radiographic method

S. no.	IRM right (in degree)	RM right (in degree)	IRM left (in degree)	RM left (in degree)
1	45	54.2	52	44.6
2	30	38.7	35	39.1
3	35	45.5	32	50.4
4	40	51.2	32	44.6
5	50	42.4	40	49.3
6	35	39.9	35	32.6
7	40	48.1	41	39.7
8	30	48.6	37.5	43.4
9	35	46.7	35	52.1
10	50	47.8	40	51
11	30	42.2	30	39.9
12	20	36.1	20	28.7
13	40	50.6	40	49.1
14	45	45.7	40	43
15	25	31.5	25	29.2
16	28	40.9	30	31.5
17	25	26.5	35	37.3
18	25	30.5	42	37.3
19	25	26.7	32	31.3
20	42	45.5	45	54.4
21	50	51.3	35	50.5
22	25	48.8	30	49.8
23	25	35.9	32	39.3
24	40	45	30	44.3
25	50	49.3	50	51.3
26	30	33.7	30	42.2
27	46	35.6	35	33.9
28	38	42.4	35	36.6
29	42	44.5	45	54.5
30	50	51.3	35	50.5

Table 2: Important values of right and left side interocclusal record method and radiographic method

Parameters	IRM right (in degree)	IRM left (in degree)	RM right (in degree)	RM left (in degree)
Sample size (N)	30	30	30	30
Mean	36.37	35.85	42.57	42.71
Std. deviation	9.42	6.87	7.60	7.84
Std. error	1.72	1.25	1.39	1.43
Median	36.50	35.00	44.75	43.20
Variance	88.65	47.23	57.78	61.51
Minimum	20.00	20.00	26.50	28.70
Maximum	50.00	52.00	54.20	54.50
Range	30.00	32.00	27.70	25.80
Interquartile range	17.75	8.50	12.60	13.30
Skewness	0.03	0.31	-0.64	-0.22
Std. error of skewness	0.43	0.43	0.43	0.43
Kurtosis	-1.29	0.64	-0.47	-1.12
Std. error of kurtosis	0.83	0.83	0.83	0.83

contrast, there are reports of bilateral symmetry of the right and left sagittal condylar guidance angle on both sides using protrusive interocclusal records with a reading of 31°. [13] Similarly, this study showed a lesser mean difference of 0.51° between the right and left sides by the IRM than the difference of 11.5°

by the panoramic RM, highlighting the inherent differences in the method of determination of condylar guidance.

A study comparing the radiographic image of the sagittal condylar path inclination and its actual anatomic outline in dry skulls found that the

Table 3: Significant difference in the interocclusal record method and radiographic method on both the right and left sides

Methods	Mean	Std. deviation	Mean rank	Critical value	P value
Right side					
IRM (in degree)	36.37	9.42	11.13	-3.867	<0.001*
RM (in degree)	42.57	7.60	16.17		
Left side					
IRM (in degree)	35.85	6.87	6.92	-3.929	<0.001*
RM (in degree)	42.71	7.84	17.65		

The RM had a significantly higher value than IRM on right and left sides

Table 4: Positive correlation between interocclusal record method and radiographic method

Test statistics	IRM left IRM right (in degree)	RM left RM right (in degree)	RM right IRM right (in degree)	RM left IRM left (in degree)
Pearson correlation	0.614	0.697	0.658	0.537
P value	<0.001*	<0.001*	<0.001*	0.002*

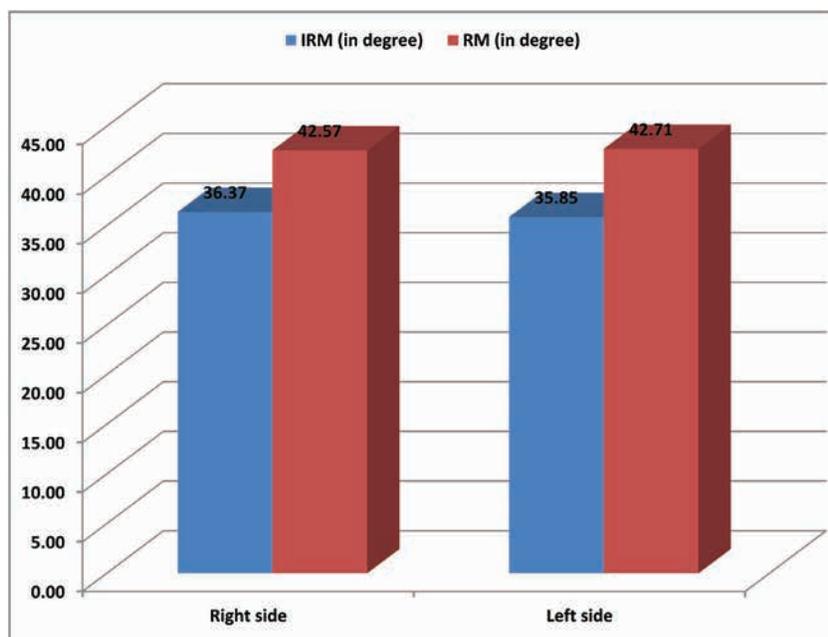
There was a significant positive correlation between IRM on the left and right side ($r = 0.614$)

There was a significant positive correlation between RM on the left and right side ($r = 0.697$)

There was a significant positive correlation between RM and IRM on the right side ($r = 0.658$)

There was a significant positive correlation between RM and IRM on the left side ($r = 0.537$)

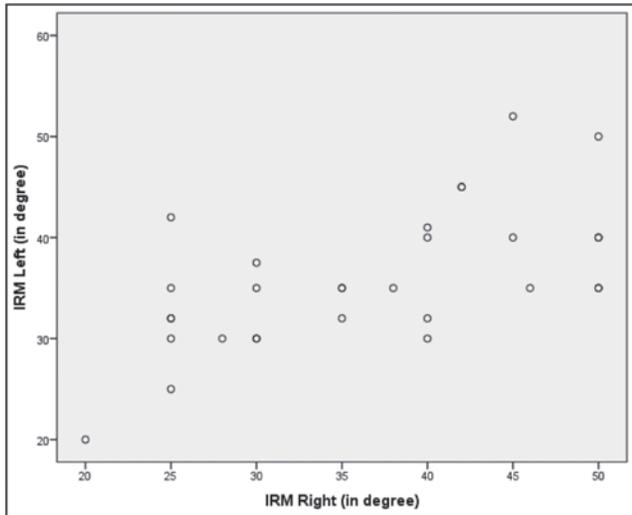
* p value is highly significant.



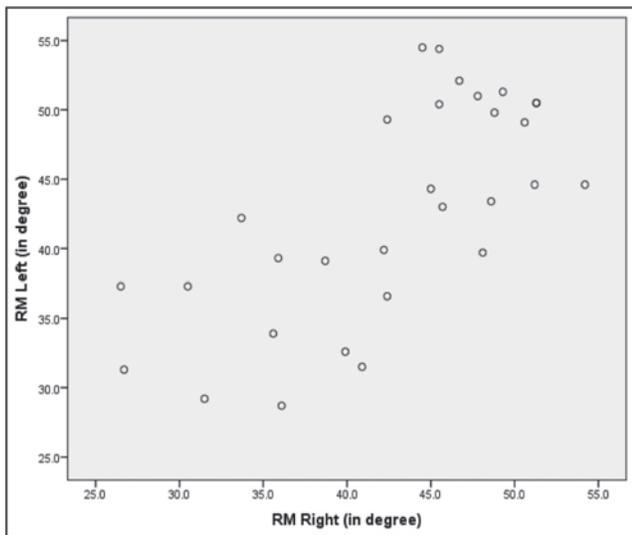
Graph 1: Comparison of the mean Condylar guidance values on the right and left side obtained from interocclusal record method and radiographic method. There was a significant difference in the IRM and RM on both right and left sides. The RM (in degree) had significantly higher value than IRM on right and left sides

radiographic values were on an average 7° greater than the skull values.^[5] This study found that the condylar guidance values by the radiographic method were greater by 17.8° and 6.9° than the interocclusal method for the right and left sides, respectively. A significant positive correlation was observed between the condylar guidance acquired using both the methods for right as well the left sides ($P < .005$).

Panoramic radiographs are the most common diagnostic tools in dentistry, have a favorable cost-benefit relationship, yield replicable results, and expose patients to relatively low doses of radiation. However, there are certain limitations such as panoramic distortion, the head and reference plane orientation, and difficulty in distinguishing the articular eminence outline from the zygomatic arch.^[14]

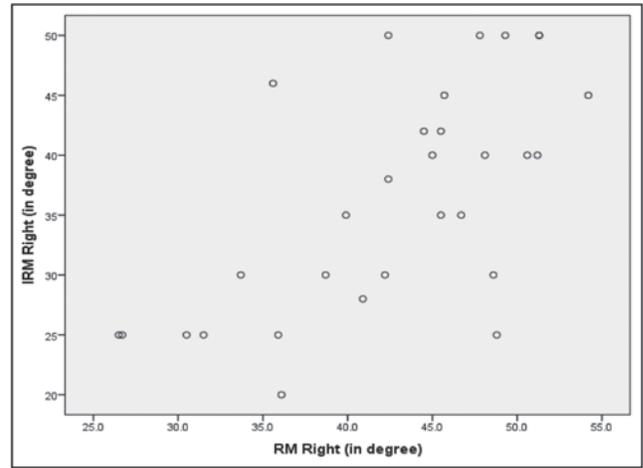


Graph 2: Graph showing a significant positive correlation of IRM on the left and right side ($r = 0.614$). There was a significantly positive correlation of IRM on the left and right side ($r = 0.614$)

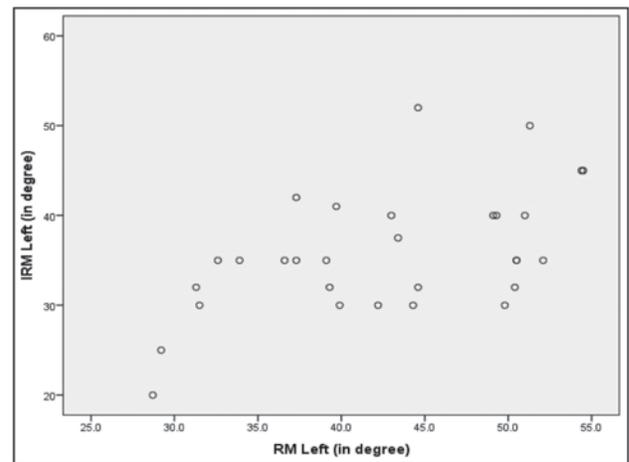


Graph 3: Graph showing a significant positive correlation of RM on the left and right side ($r = 0.697$). There was a significantly positive correlation of RM on the left and right side ($r = 0.697$)

The positions of the two lines relative to each other may vary with the change in beam direction due to positioning errors. Further, the articular eminence inclination in the radiographic image in this study was digitally visualized by a line joining the heights of curvature in the glenoid fossa and the articular eminence to represent the mean sagittal condylar path inclination. This may be different from the guiding inclination with approximately 8–10 mm of lateral movement, which is the clinically significant range of condylar guidance. Though there are few disadvantages, the panoramic radiograph is still



Graph 4: Graph showing a significant positive correlation of IRM with RM on the right side ($r = 0.658$). There was a significantly positive correlation of IRM with RM on the right side ($r = 0.658$)



Graph 5: Graph showing a significant positive correlation of IRM with RM on the left side ($r = 0.658$). There was a significantly positive correlation of IRM with RM on the left side ($r = 0.658$)

very useful for comparison between right and left sides as it shows both the TMJs with relatively same magnification errors ($\times 1.2$).^[10] Unlike the other TMJ-specific radiographs, which are subject to projection errors, it is a reproducible radiograph.

Also, the condylar element glide-in-slots in most articulators provide a rectilinear stimulation of the curvilinear path of the condyle, thus creating a difference between the existing biological situation in the patient and the mechanical articulator.^[3] It is possible that the frictional inhibition of movement of the condylar components of the articulator might introduce errors in the values of the condylar guidance.^[15]

Although direct comparisons between a functional method and a radiographic method would seem improbable,^[16] this study found a strong degree of

correlation between the condylar guidance determined by the two methods.

The choice of technique depends on the specific clinical needs of occlusal rehabilitation rather than an overriding concern for precise condylar pathways. OPG could be used as an alternative to clinical methods to overcome the disadvantages associated with conventional techniques. Further studies are required to evaluate the accuracy of radiographs for determining the condylar guidance angles with advanced radiographic techniques.

DECLARATION OF PATIENT CONSENT

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

FINANCIAL SUPPORT AND SPONSORSHIP

Nil.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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